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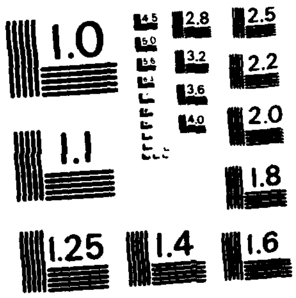

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AFFSE REPORT 1/83

AR 003-271

Department of Defence

Defence Science and Technology Organisation

Armed Forces Food Science Establishment

Scottsdale, Tasmania

AFFSE REPORT 1/83

Processing Cost Reduction Program
Freeze Dried Foods [U]

K. D. HOEY

Approved for Public Release

March, 1983

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DEPARTMENT OF DEFENCE
ARMED FORCES FOOD SCIENCE ESTABLISHMENT

AFFSE REPORT 1/83

PROCESSING COST REDUCTION PROGRAM
FREEZE DRIED FOODS (U)

K. D. HOEY

ABSTRACT

The processing cost of freeze dried meals produced at AFFSE was reduced by an average of 31% over the period 1974 to 1979. The cost reduction was achieved by increasing the throughput rate of the freeze drying plant by an average of 45%.

It is concluded that further cost reductions could be achieved by formulation changes and by the use of lower cost, but not lower quality, ingredients. (U)

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Armed Forces Food Science Establishment
P.O. Box 147
SCOTTSDALE Tasmania 7254

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16. SUMMARY:

An experimental program initiated in 1974 to reduce the processing costs of freeze dried meals being produced at the AFFSE for the Australian Army is described.

The processing cost of freeze dried meals produced at the AFFSE over the period 1974 to 1979, was reduced by an average of 31%. The throughput rate was increased by an average of 45% over the same period.

It is concluded that further cost reductions could be achieved by formulation changes and by the use of lower cost, but not lower quality ingredients. (U)

CONTENTS

PROCESSING COST REDUCTION PROGRAM
FREEZE DRIED FOODS

INTRODUCTION

The Armed Forces Food Science Establishment (AFFSE) has been involved in the development of freeze dried meals for use in Army rations since the early 1960's.

In 1972 a freeze drying plant was commissioned at AFFSE. The plant was installed to:

- further develop freeze dried foods for use in Australian Army Patrol Ration packs;
- provide dried foods for the training requirements of the Australian Army: and
- provide operating data for use by the Australian food industry in times of mobilization.

Although freeze dried meals produced on the pilot plant at AFFSE were acceptable for Army training requirements, cost remained high. Therefore, in 1974 the AFFSE initiated a research project to try to reduce the processing costs of freeze dried meals being produced at AFFSE for the Australian Army.

Concurrently attempts were made to increase the range of freeze dried meals and to improve acceptability.

As an initial approach the effects on processing costs of the following variables were examined:

- heating plate temperature profile
- vacuum chamber pressure
- vacuum break condition
- product moisture level
- tray loading density
- wet material solids concentration.

This paper reports the effect on throughput rates and processing cost of the research program.

BACKGROUND

USER REQUIREMENTS:

The design, development and procurement of freeze dried foods for use in Australian Army Patrol Ration One Man (PRIM) pack is dictated by a number of Army documents including Army Equipment Planning Summary (AEPS) No. 69 — Operational Rations, and Army Staff Requirement (ASR) 69 1 —Operational Rations. These documents require that freeze dried meals for the PRIM pack should be:

- nutritionally adequate
- highly acceptable and satisfying
- varied
- simple to prepare; and
- readily digestible.

Furthermore, service requirments dictate that the meals should be:

- as compact and as light as is consistent with other essential characteristics;
- produced as economically as possible;
- packaged so that the contents are protected against exposure to the environment, and
- have a preparation time of approximately 5 minutes

The meal must have a storage life of at least one year under tropical conditions, and at least two years under temperate conditions

THE FREEZE DRYING PROCESS:

Freeze drying is the process of removing ice from a frozen food by applying heat under low water vapour pressure so that the ice sublimes For this it is necessary to reduce the water vapour pressure to below the triple point value (4.58 torr). Heat is applied to the food either by conduction or by radiation Appendix I is a simplified representation of food being freeze dried It consists of a frozen core with a dry layer around it.

The water is initially sublimed from the surface of the food with the ice core receding as the drying continues The frozen core is maintained at sub-zero temperatures (below melting point — 10°C to -20°C) throughout the drying process. The temperature of the dried layer is maintained at a low temperature to reduce organoleptic deterioration. Although radiation temperatures of approximately 150°C are common in freeze drying, the dried food layer is cooled by the low temperature water vapour subliming from the ice interface. It is usually maintained below 50°C (Appendix 2)

The chamber pressure is generally maintained below 1 torr absolute pressure which is consistent with maintaining the frozen core of the food Because the water in the food remains in a frozen state until sublimation, there is no shrinkage of the food during the process

Freeze drying is capital and energy expensive. Because the capital equipment cost per unit of dry product output is high, a considerable amount of development effort has been devoted to ways of increasing the freeze drying rate (a 10 to 14mm thick slab of casserole type meal can take 6 to 7 hours to freeze dry to less than 2% moisture)

The freeze drying rate is determined by the rate at which energy (heat) is supplied to the frozen

ice core and the rate at which water vapour is removed from the ice interface. In general terms:

$$\text{Energy (Sublimation) Rate} \propto \frac{K \Delta t}{d}$$

Where K = thermal conductivity of dried layer
Δt = temperature difference surface of food and ice interface
d = thickness of dried layer

$$\text{Diffusion Rate} \propto \frac{D \Delta p}{d}$$

Where D = diffusion coefficient
Δp = pressure difference vapour at ice interface and surface of food
d = thickness of dried layer

During freeze drying the sublimation rate and diffusion rate are in equilibrium. The heat transfer rate and the water removal rate must be increased simultaneously if drying time is to be reduced. Reduction of food thickness (d) represents the easiest approach of increasing drying rate. In some instances this is limited by ingredient size.

The heat stability is largely dictated by the temperature tolerance characteristics of the food. Furthermore, the pressure difference (Δp) is influenced by the melting characteristics. Therefore changes to the thermal conductivity and the diffusion coefficient are necessary to achieve an increased freeze drying rate.

Since the thermal conductivity increases with pressure (appendix 3) the sublimation rate can be increased by raising the drying chamber pressure. However, since the resistance to water vapour removal increases at higher pressure, the diffusion rate will decrease and a pressure may be reached which causes melting. Thus the heat transfer rate will limit the overall rate of freeze drying at low pressures, and the diffusion rate at higher pressures.

An alternative method of trying to reduce the freeze drying time has been proposed by Mellor (1967). This method involves cycling the chamber pressure to try to separately optimise the sublimation rate and the diffusion rate whilst maintaining the ice interface below the melting temperature.

The cyclic pressure process involves alternately cycling the vacuum chamber pressure between a "high" pressure usually for ' to 1 minute to increase the heat transfer rate, and a "low" pressure usually for 3 to 4 minutes to increase the water removal rate. A hydrodynamic flow can be produced when the external vacuum pressure is suddenly reduced in the chamber, thus aiding water removal (Appendix 4).

Although the cyclic process can reduce freeze drying time for some food products where the heat input rate is limited by the use of a low chamber pressure operation, it is probably inferior to a near optimal constant pressure process (Litchfield, Liapis & Farhadpour, 1981).

MATERIALS AND METHODS

FREEZE DRYING PLANT:

The freeze drying operation is undertaken at the AFFSE in a pilot scale freeze drying plant which was manufactured in Australia by James Budge Pty. Ltd. It was commissioned at AFFSE in 1972 (Appendix 5). The plant is a batch type freeze dryer with radiant heating plates. A heat transfer fluid is used as the heating and cooling source. The temperature can be controlled in the range 20°C to

150°C ± 2°C. The plate heating area is 23 m^2. A two stage mechanical evacuation system comprising a roots type blower booster pump and a rotary valve pump is capable of achieving a vacuum of 0.1 torr within 5 minutes in the vacuum chamber.

A 23 m^2 refrigerated condenser is located in the vacuum chamber to condense water vapour. The refrigeration system is capable of maintaining a temperature of -40°C at the condenser at a chamber pressure of 1 torr at a freeze drying rate of 60 kg/hr of water.

Food is loaded on to black anodised aluminium freeze drying trays which are transferred from a blast freezer to the vacuum chamber on carrier trollies. The trays interleave between the heating plates in the vacuum chamber. Each tray is 870 long x 420 wide x 16 mm deep (0.37 m^2 area) and there are 64 trays on the carrier trolley. The vacuum chamber is 1.54 m in diameter and 3.66 m long.

Thermocouples connected to a 12 point temperature recorder, and a pirani type vacuum recorder are used to monitor the process. The heating plate temperature profile and the vacuum chamber pressure can be controlled automatically using preset programs. The freeze drying plant is capable of processing approximately 250 kg of wet material in an 8 hour shift to a product moisture content of less than 2%.

FREEZE DRIED MEALS:

There are six freeze dried meal varieties used in the PRIM packs. The average mass of each of the packs is 850g, and the bulk is 5.4L (190 x 150 x 190). Each pack contains two freeze dried meals weighing 110g each. The meals are vacuum packed (30 torr absolute) in flexible laminate pouches (polyester/polyethylene/foil/polyethylene) and can be reconstituted inside the pouch if required using 350 mL of water.

Precooked ready-to-eat casserole type meals containing large proportions of identifiable cuts of various types of meat have been shown by field surveys as being the most acceptable to the Australian Servicemen. In designing the product formulation, careful consideration is given to:

(1) the quality of the raw materials — a high percentage of fat inhibits complete rehydration of meat and is liable to rancidity.

(2) selection of ingredients — foods with high soluble solids content are generally more difficult to freeze dry; and

(3) cooking method — tenderness of cooked freeze dried meat is significantly affected by the cooking method (Driver & Venkata Raman, 1977).

The six meal varieties currently used (1983) in the PRIM packs are:

Lamb and Vegetable Curry Beef and Green Beans	Ration Pack Menu A
Beef and Onions Roast Pork and Gravy	Ration Pack Menu B
Spaghetti and Meat Sauce Savoury Steak Fingers	Ration Pack Menu C

Each of the six meals has a taste panel rating of at least 6 for acceptability (9 point Hedonic Scale, Appendix 6) which corresponds to a "like slightly" rating in descriptive terms (Appendix 7).

METHOD:

All of the freeze dried meals are prepared at AFFSE from fresh or frozen raw materials using standard operation procedures (Appendix 8).

The raw materials and freeze dried products are required to meet the Australian Defence Forces

Food Specifications (ADFFS) and in-house standards. The cooked meals are spread onto freeze drying trays, frozen in a blast freezer to -25°C and stored overnight, prior to the freeze drying operation.

Previous experience on a laboratory size freeze drying plant had shown that for each meal variety:

(1) the product surface temperature should be maintained below 50°C to prevent excessive heating; and

(2) the frozen core or deep material temperature should be maintained at less than -10°C to prevent melting.

Typical heating plate temperature profiles and vacuum chamber pressure profiles for each of the meals are listed in Appendix 9. A drying time of no greater than 8 hours was dictated by normal shift requirements.

The product surface temperature and deep core temperatures were monitored by use of thermocouple probes. The result of in-house taste panel assessments on the freshly dried product was used to monitor product acceptability. The acceptability of the freeze dried meals was to be maintained or improved as the meals were to be used during Army training.

All the raw materials were routinely inspected for conformity to ADFFS.

Each batch of freeze dried meals was routinely tested to meet microbiological standards for standard plate count, coliforms, ***E. Coli***, **Salmonellae,** staphylococci, and yeasts and moulds. Moisture content was determined on a representative sample of each batch of freeze dried meal. Analyses for moisture, fat, ash, protein, salt, ascorbic acid, and thiamin were conducted on composite samples from each meal (Appendix 10).

Acceptability was determined on the freshly prepared and stored product by a semi-trained in-house taste panel (Appendix 6).

Acceptability to Army users was also undertaken on some meals (Appendix 14).

RESULTS AND DISCUSSION

The dry solids throughput rates for freeze dried meals were increased by an average of 45% in the period 1974 to 1979 (Appendix 11). The improvement in throughput rates was achieved by:

- reformulation changes which produced meals that had relatively higher solids concentrations;
- structures that freeze dried more rapidly; and
- the use of higher average heating temperature profiles.

The average wet/dry ratios were reduced from 3.91 in 1974 to 3.34 in 1979, an average improvement in solids concentration of 18%. The more concentrated meals had increased thermal conductivities in the dry layer. It is this layer which limits the heat penetration from the heating plates to the cold ice front. The depression in the freezing and melting points of the products due to the increased solids concentrations was not a limiting factor. However, as the solids concentration increased, the wet materials became more difficult to spread uniformly on to the freeze drying trays. Uniformity of material thickness is important to ensure uniform drying. The increased thermal conductivity facilitated the use of increased tray loading densities and higher average heating temperature profiles.

The tray loading densities were progressively increased from an average of 9.6 kg/m² in 1974 to

11.2 kg/m^2 in 1979, an increase of 17% (Appendix 9). The loading densities for all the products except pork were approaching an optimal level. The loading density for pork was dictated by slice thickness. The tray loadings were not limited by the dimensions of the equipment.

The maximum initial heating plate temperature was progressively increased from 100°C in 1974 to 150°C in 1979 (Appendix 9). Further increases in temperature are limited by steam pressure. Furthermore trials on a small laboratory freeze dryer at the AFFSE have indicated that improvements to throughput rates by using higher initial heating plate temperatures are only marginal. A temperature of 170°C could not be maintained for more than 2 hours if heat damage to the surface of the product was to be avoided. There was little improvement to the throughput rate using the higher initial temperature, and an increased risk of scorching the surface of the product.

Very little improvement in drying rates was achieved by using cyclic freeze drying methods on the meals being dried at AFFSE. As the risk of thawing of foods is increased when using this method, further development of the technique was referred to laboratory trials.

Drying times were slightly reduced by increasing the final moisture content from less than 2%, to 3%. The higher moisture level did not seem to adversely affect the product quality nor storage stability. The overall acceptability of each of the meals was maintained throughout the program.

No differences in acceptability were detected between products where the vacuum in the freeze drying chamber was equalised with either air or nitrogen.

The processing costs of freeze dried meals were reduced by an average of 31% in the period 1974 to 1979 (Appendix 15). These reductions were due to the increased dry solids throughput rates. Processing costs are inversely proportional to the dry solids throughput rate. The largest cost reduction of 38% was achieved for Savoury Steak Fingers. The lowest cost reduction achieved was 21% for Beef and Onions. As there is considerable difference in the dry solids throughput rates between the different freeze dried meals, there is further scope for reducing processing costs by reformulation. Also as raw material costs are the major cost component of freeze dried meals, reformulation of meals using lower cost ingredients on a dry solids basis, or complete replacement of meals would seem to offer considerable potential for achieving additional cost reductions (Appendix 13). Major reformulation changes were not undertaken as part of the experimental program because of the need for all freeze dried products to meet specification requirements.

CONCLUSIONS

The processing costs of freeze dried meals produced at AFFSE for the Australian Army were significantly reduced in the period 1974 to 1979 by increasing the dry solids throughput rate of all meals dried in the Budge freeze drying plant at AFFSE.

Based on in-house taste panel assessments and some field trials, the acceptability of each of the meals was maintained.

There would appear to be potential for further reduction in the cost of freeze dried meals produced at the Establishment by formulation changes and particularly the use of lower cost (but not lower quality) ingredients.

Because there is a desire to improve the acceptability of freeze dried meals, there is a need to continue product development and to obtain regular field evaluations to provide current information on consumer preference and service suitability and needs.

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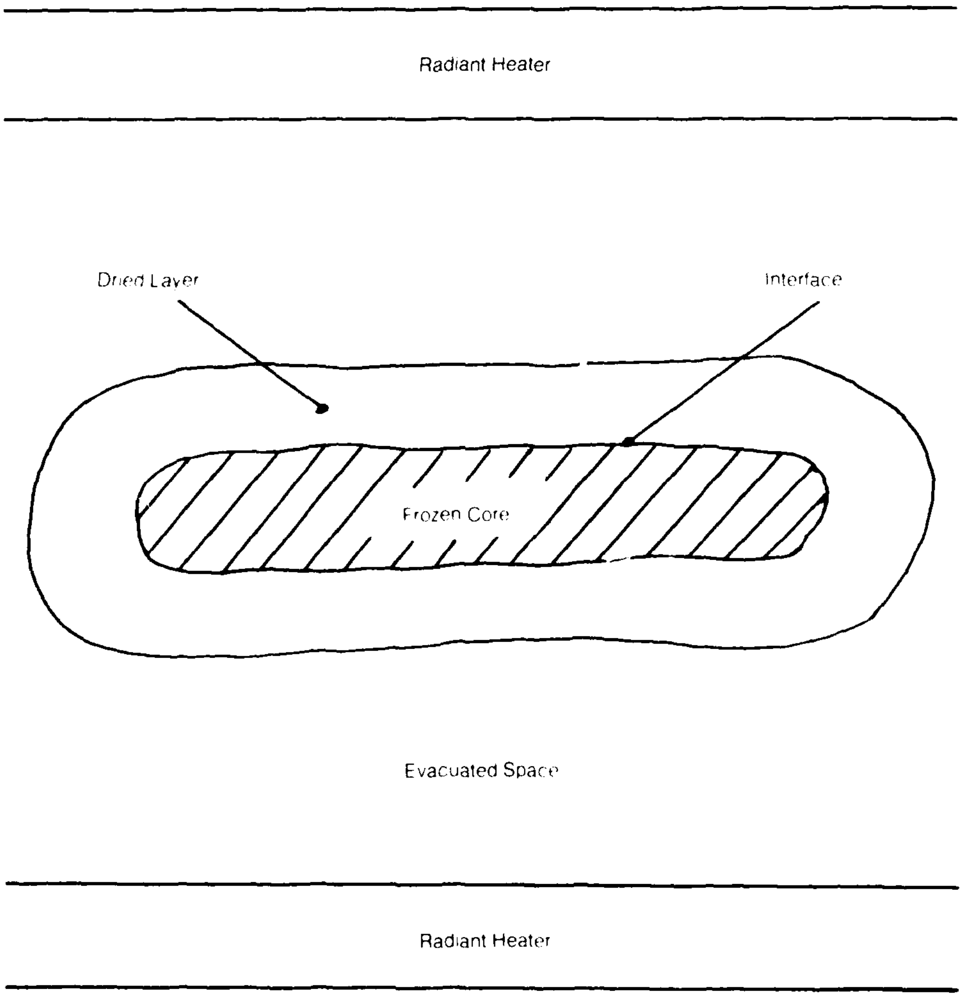
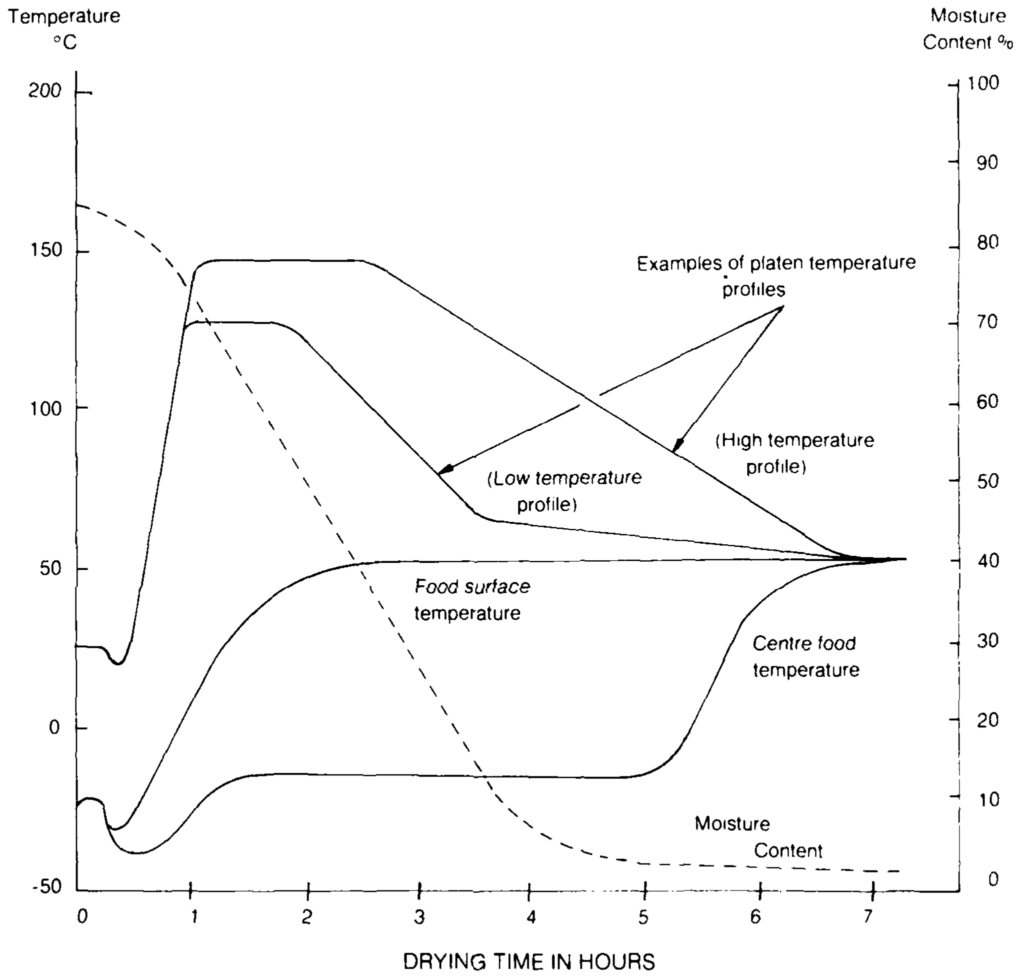
APPENDIX 1

REPRESENTATION OF FOOD BEING FREEZE DRIED



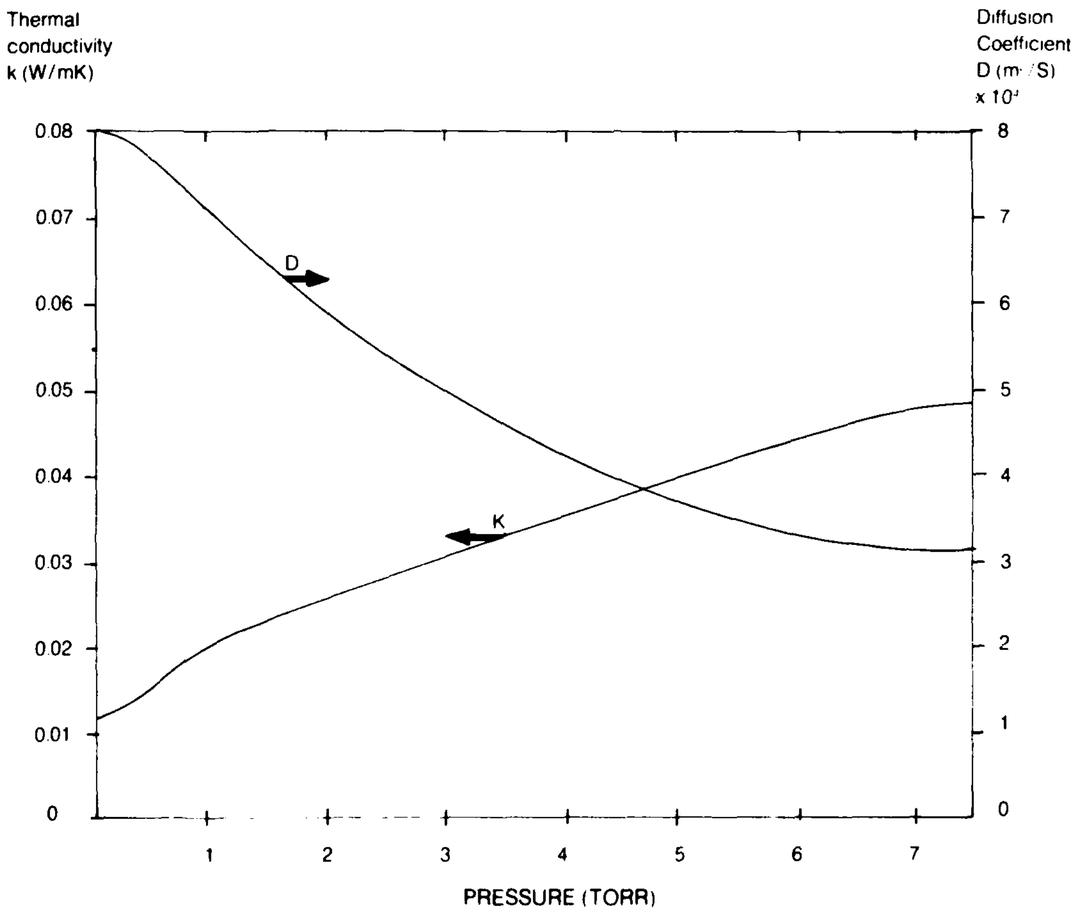
APPENDIX 2

FREEZE DRYING TEMPERATURE AND MOISTURE CONTENT PROFILES



APPENDIX 3

THERMAL CONDUCTIVITY AND DIFFUSION COEFFICIENT OF FREEZE DRIED TURKEY VERSUS PRESSURE



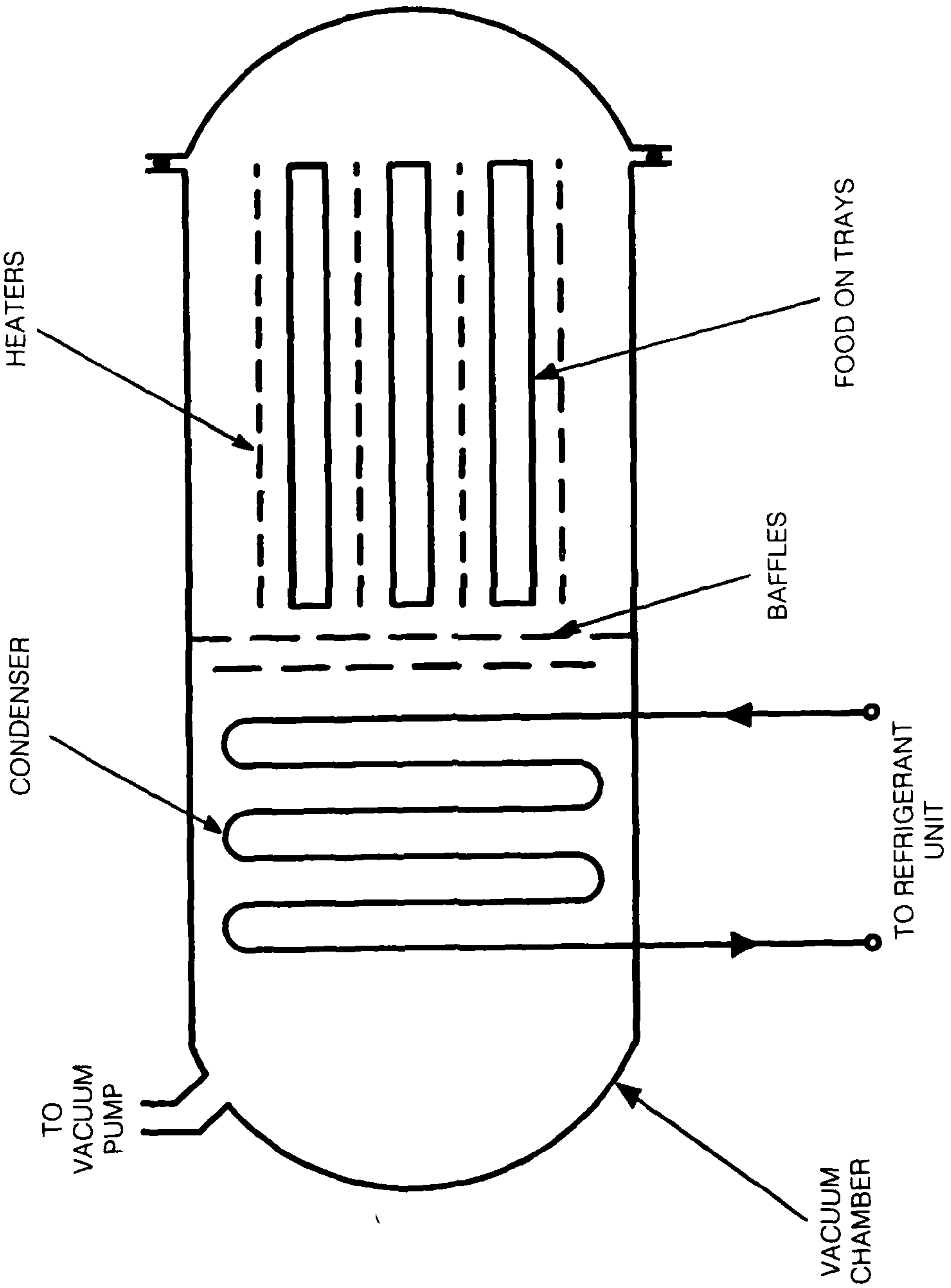
APPENDIX 4

TYPICAL CYCLIC CONDITIONS FOR FREEZE DRIED MEALS (1974)

MEAL	HIGH PRESSURE	LOW PRESSURE	TOTAL CYCLE TIME HOURS	TOTAL DRYING TIME HOURS
Beef and Green Beans	15mm for 1 min.	0.5mm for 3 mins	5	7½
Lamb & Vegetable Curry	22mm for 1 min	0.5mm for 3 mins	4	7½
Savory Steak Fingers	7mm for 1 min	0.5mm for 3 mins	6½	6½
Beef and Onions	7mm for 1 min	0.5mm for 3 mins.	6½	7¼
	22mm for 1 min	0.5mm for 3 mins	6½	7
Roast Pork and Gravy	15mm for 1 min.	0.5mm for 3 mins.	3½	7½
	50mm for 1 min	0.5mm for 3 mins	6½	7½

APPENDIX 5

TYPICAL LAYOUT BATCH TYPE FREEZE DRYING CHAMBER



APPENDIX 6

TYPICAL TASTE PANEL ACCEPTABILITY RATINGS — FRESHLY COOKED MEALS, AND FREEZE DRIED MEALS FOLLOWING STORAGE AT 30°C (1979)

MEAL	FRESHLY COOKED MEALS				FREEZE DRIED MFALS OVERALL ACCEPTABILITY			
	APPEARANCE	TEXTURE	FLAVOUR	OVERALL	0*	6 months	12 months	24 months
Beef and Onions	6	7	7	6	6	6	6	6
Savoury Steak Fingers	7	7	6	6	6	6	6	6
Beef and Green Beans	7	8	8	8	6	6	6	6
Lamb and Vegetable Curry	7	6	7	7	6	6	6	6
Roast Pork and Gravy	7	7	7	7	6	6	6	6

* Product rated within 2 days of freeze drying

Acceptability score based on 9 point Hedonic Scale

APPENDIX 7

TYPICAL ACCEPTABILITY RATING SHEET USED FOR RATING FREEZE DRIED MEALS

HEDONIC RATING SCALE
(9 point)

NAME .... **DATE** .... **TIME** ....

PRODUCT ....

This product is to be rated for APPEARANCE, TEXTURE, FLAVOUR (TASTE AND AROMA) and OVERALL (GENERAL) ACCEPTABILITY. Please place a tick against what you consider to be a suitable rating. Any other comments should be given in the space provided.

RATING		APPEARANCE						TEXTURE					
		1	2	3	4	5	6	1	2	3	4	5	6
Excellent	9												
Very Good	8												
Good	7												
Fair	6												
Neutral	5												
Rather Poor	4												
Poor	3												
Very Poor	2												
Extremely Poor	1												
Any Additional Comments													

		FLAVOUR						OVERALL ACCEPTABILITY					
		1	2	3	4	5	6	1	2	3	4	5	6
Like Extremely	9												
Like Very Much	8												
Like Moderately	7												
Like Slightly	6												
Neither Like Nor Dislike	5												
Dislike Slightly	4												
Dislike Moderately	3												
Dislike Very Much	2												
Dislike Extremely	1												
Any Additional Comments													
Do you normally like this product?													

APPENDIX 8

TYPICAL FREEZE DRIED MEAL PRODUCTION PREPARATION PROCEDURE SHEET

BEEF & ONIONS 1979

INGREDIENTS	WEIGHT	METHOD
BEEF OIL WATER	90 kg 480 mL 39.6 L	PRE HEAT OIL SEAL MEAT ½ HOUR ADD WATER SIMMER ½ HOUR
ONIONS DEHYDRATED WATER	4.8 kg 5 L	SOAK ONIONS FOR ½ HOUR ADD STAGE 1 SIMMER ½ HOUR
GRAVOX FLOUR BEEF BOOSTER CLEAR JEL SALT PEPPER PARISIENNE ESSENCE WATER	1.85 kg 1.85 kg 0.93 kg 1.85 kg 0.46 kg 0.039 kg 335 mL 10 L	BLEND FLOUR & 4 L OF WATER ON MIXING MACHINE. ADD TO STAGE 3 AND MIX WELL PLACE IN BELL STIR SIMMER FOR 10 MINUTES

APPENDIX 9

TYPICAL FREEZE DRYING PROCESSING CONDITIONS AND PERFORMANCE DATA

1974, 1977, 1979

HEATING PLATE TEMPERATURE PROFILE °C x HR	DRYING TIME hr	CHAMBER PRESSURE torr	VACUUM BREAK	AVERAGE TRAYS PER RUN	LOADING DENSITY kg/m²	AVERAGE WET LOAD kg	AVERAGE DRY PRODUCT kg	AVERAGE WET/DRY RATIO	MOISTURE %	BATCHES
BEEF AND GREEN BEANS										
1974 100 x 4/4 to 50	8	0.5	NIT*	63	8.4	194	43	4.56	1.1	23
1977 120 x 4½/3 to 50	7½	0.5	AIR	63	11.5	270	56	4.80	1.9	7
1979 150 x 3½/3 ½ to 60	7¼	1.0	AIR	62	11.9	272	65	4.18	1.1	33
LAMB & VEGETABLE CURRY										
1974 100 x 4½/3¼ to 50	7¼	0.5	NIT	58	10.6	228	61	3.70	1.7	15
1977 120 x 3½/3½ to 50	7	0.5	AIR	62	12.3	280	84	3.33	1.5	5
1979 150 x 3½/4¼ to 70	7½	1.0	AIR	61	13.5	302	92	3.30	1.7	25
SAVOURY STEAK FINGERS										
1974 100 x 2½/4½ to 50	7	0.5	NIT	58	9.9	208	50	4.21	1.2	18
1977 120 x 4/2½ to 60	6½	0.5	AIR	64	10.9	258	64	4.08	1.4	6
1979 150 x 1¼/5 3/4 to 70	7	1.0	AIR	63	10.9	255	81	3.14	1.4	27
BEEF AND ONIONS										
1974 100 x 4/3 ½ to 50	7½	0.5	NIT	64	11.2	261	55	4.73	1.1	17
1977 120 x 4/3 to 60	7	0.5	AIR	64	10.8	256	57	4.48	1.4	7
1979 150 x 3/4½ to 60	7½	1.0	AIR	62	11.3	258	70	3.67	1.0	33
ROAST PORK AND GRAVY										
1974 100 x 4/3 ½ to 50	7½	0.5	NIT	58	6.9	147	59	2.47	1.1	15
1977 120 x ½ to 50	7	0.5	AIR	64	8.1	191	75	2.55	1.6	6
1979 125 x 3/3 to 70	6	1.0	AIR	59	8.6	191	79	2.42	0.7	21

* NIT = Nitrogen

APPENDIX 10

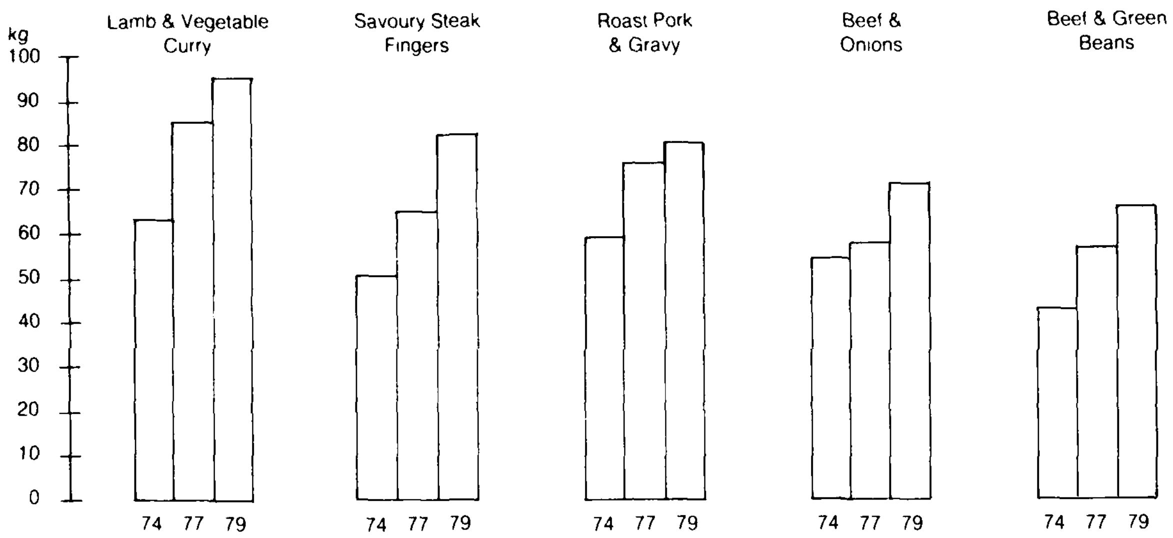
CHEMICAL AND MICROBIOLOGICAL ANALYSIS OF FREEZE DRIED MEALS — POUCHED SAMPLES — 1979

	Beef & Beans	Lamb & Vege Curry	Savoury Steak Fingers	Beef & Onions	Roast Pork & Gravy
Moisture %	2.1	2.1	1.1	1.7	1.1
Fat %	21	23	10	11	24
Ash %	6.3	4.2	8.7	6.7	5.4
Protein %	57	51	61	59	66
*CHO's %	13	19	19	21	4
Salt %	3.5	1.2	5.2	3.7	2.4
Thiamin mg/100g	0.2	—	0.2	0.2	0.9
Ascorbic Acid mg/100g	21	15	24	14	19
Energy kJ/100g	1960	2040	1730	1760	2060
Standard Plate Count/g	10-3,600	70-15,000	10-6,000	10-1,100	30-48,000
(mean S.P.C./g)	320	3240	710	100	2630
Coliforms/g	<1	<1	<1-4	<1	<1-21
E. Coli Type I/g	<1	<1	<1	<1	<1-18
Yeasts/g	<1-4	<1	<1	<1-4	<1-480
Moulds/g	<1-5	<1-7	<1-3	<1-2	<1-1
Coagulase Positive Staphylococci/g	<3-23	<3	<3	<3-4	<3-93
Salmonella in 25g	Absent	Absent	Absent	Absent	Absent

* CHO = Carbohydrate

APPENDIX 11

COMPARISON OF AVERAGE DRY PRODUCT YIELD PER BATCH — FREEZE DRIED MEALS 1974, 1977, & 1979



Dry product yield/batch kg

1974	61 (1)	50 (1)	59 (1)	55 (1)	43 (1)
1977	84 (1 38)	64 (1 28)	75 (1 27)	57 (1.04)	56 (1 30)
1979	92 (1 51)	81 (1 62)	79 (1 34)	70 (1 27)	65 (1 51)

( ) Brackets indicate comparative yield from year to year for each product

APPENDIX 12

TYPICAL FREEZE DRYER OPERATING COST PER BATCH 1979 (AT 1981 COSTS)

Basis - Single 8hr shift operation
- 220 days p a
- 1981 costs
- * semi variable depending on meal being freeze dried

	$	%
Depreciation at 15% on $260 000	177	68
Heating energy *	4	1
Other power costs including freezing and low humidity at 4 0c kw hr *	23	9
Freeze dryer operator 2 hr at $8/hr	16	6
Other operator costs 3 hr at $5/hr	15	6
Labour on-costs at 25 %	7	3
Supervision quality control	12	5
Maintenance utilities	5	2
	259	100

APPENDIX 13

PROCESSING AND MATERIAL COSTS FOR FREEZE DRIED MEALS

1979 (AT 1981 COSTS) c/POUCH

FREEZE DRIED MEAL 110g POUCH	F D YIELD kg	MATERIAL COSTS	PREPARATION & PACKAGING LABOUR COSTS	FREEZE DRYING COST	TOTAL COST PER POUCH*
Beef & Green Beans	65	87 6	36 1	43 8	167 5
Lamb & Vegetable Curry	92	105 4	35 4	30 9	171 7
Savoury Steak Fingers	81	88 0	62 5	35 1	185 6
Beef & Onions	70	87 7	80 0	40 7	208 4
Roast Pork & Gravy	79***	225 4	65 6	37 1**	328 1

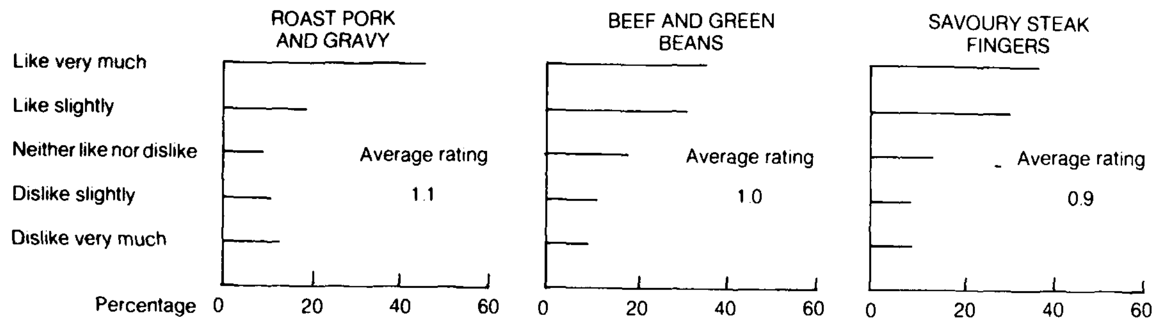
* Only includes costs listed in table to illustrate the relative cost of the major cost elements Packaging costs are similar for each meal except for pork and gravy which required combination of pork and gravy at pouch packing operation

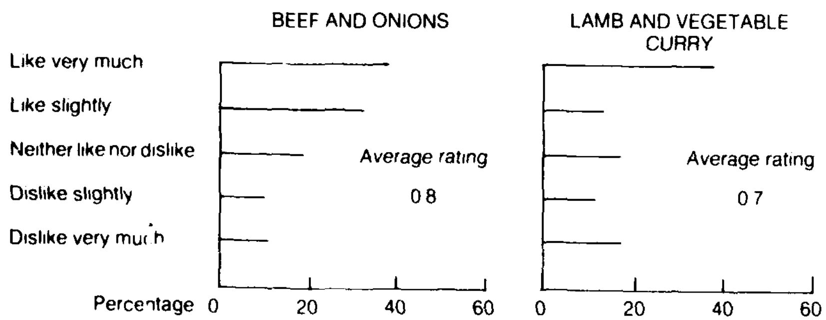
** Gravy dried separately

*** Preparation area limitation

APPENDIX 14

FIELD EVALUATION OF ACCEPTABILITY OF AUSTRALIAN RATION PACKS 1974-1977





Basis of Rating

Like very much	+2
Like slightly	+1
Neither like nor dislike	0
Dislike slightly	-1
Dislike very much	-2

APPENDIX 15

PROCESSING COSTS FOR FREEZE DRIED MEALS

1974, 1977, & 1979 (AT 1981 COSTS) ¢/POUCH

YEAR	1974	1977	1979
Beef & Green Beans	66.3 (1)	50.8 (0.77)	43.8 (0.66)
Lamb & Vegetable Curry	46.7 (1)	33.9 (0.73)	30.9 (0.66)
Savoury Steak Fingers	57.0 (1)	44.5 (0.78)	35.1 (0.62)
Beef & Onions	51.8 (1)	50.0 (0.96)	40.7 (0.79)
Roast Pork & Gravy	49.6 (1)	39.0 (0.79)	37.1 (0.75)

( ) Brackets indicate comparative ratio of cost from year to year.

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